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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering

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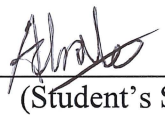

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THE EFFECTIVENESS OF MICONIZED POWDER AND CRUMB RUBBERS AS FINE AGGREGATES REPLACMENT IN ULTRA-HIGH PERFORMANCE CONCRETE

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ABSTRAK

Konkrit prestasi ultra tinggi (UHPC) adalah kelas terbaru di dalam bahan pembinaan yang mempunyai kekuatan yg tinngi. Pasa masa kini, penggunaan bahan kitar semula atau sisa produk pembinaan mempunyai potensi tinggi dan perlu diutamakan sebagai bahan alternative di dalam campuran konkrit. Penyelidik yang dahulu telah mengkaji tentang keberkesanan pergunakan tayar terpakai sebagai bahan penggantian konvensional dan konkrit kekuatan tinggi. Kajian sebelum ini telah mendapati serbuk-sisa getah (microWRP) telah digunakan sebagai penganti pasir konvensional. Disampaing itu, kajian ini juga tertumpu kepada kesan menggunakan crumb getah dan microWRP aduan UHPC. Tahap gantian crumb getah dan microWRP terdiri daripada 10%, 20%, 30%, 40%, dan 50% daripada jumlah keseluruhan pasir yng digunakan. Memenuhi penggunaan crumb dan microWRP di UPHC, sifat-sifat kebolehkerjaan dan kekuatan mampatan UPHC dan satu siri UHPC memperbadankan meremahkan getah dan miroWRP (rubberized UHPC) telah dikajikan. Kekuatan kemampatan UHPC dan getah-UHPC telah diuji selepas 7, 14 dan 28 hari dari hari pengawetan. Di samping itu, hasil kajian ini dijangka akan menghubungkait keberkesanan menggabungkan pelbagai peringkat crumb getah dan microWRP dengan tertakluk kepada sifat kebolehkerjaan dan kekuatan mampatan UHPC-galanya yang ada telah dikaji semula. Keputusan percubaan mendedahkan bahawa penubuhan crumb getah dan microWRP ke dalam campuran UHPC boleh menyebabkan pengurangan kebolehkerjaan dan kekuatan mampatan. Dalam kajian ini mendapati bahawa peningkatan peratusan crumb getah dan microWRP sebagai sebahagian daripada penggantian pasir, kurangkan kebolehaliran dalam konkrit. Dari permerhatian, peratusan crumb getah dan microWRP sebagai ganti pasir tealh meningkat, malakala kekuatan mampatan getah-UHPC akan berkurangan.

ABSTRACT

Ultra-high performance concrete (UHPC) is a relatively new class of advanced construction material and has superior strength. Nowadays, the need to incorporate recycled or waste product as alternative materials in concrete mixture is become interests and great potential to be explored. Previous researches have been studied on the effectiveness of using recycled waste tyres as replacement materials in conventional and high strength concretes. In comparison with previous studies, micro-waste rubber powder (microWRP) was used as fine aggregate to replace the–conventional sand. As a consequence, this study was focused on the effect of using crumb rubber and microWRP in UHPC mixture. The levels replacement of crumb rubber and microWRP comprises of 0%, 10%, 20%, 30%, 40% and 50% from the weight of fine aggregate used. To fulfil the utilization of crumb and microWRP in UPHC, the workability properties and compressive strength of UPHC and a series of UHPC incorporating crumb rubber and miroWRP (rubberized-UHPC) was examined. The compressive strength of UHPC and rubberized-UHPC was tested for 7, 14 and 28 days of curing days. Further, the expected outcome of this study will correlate the effectiveness of incorporating different levels of crumb rubber and microWRP with subjected to the workability properties and compressive strength of rubberized-UHPC has been reviewed. The experiment results revealed that the incorporation of crumb rubber and microWRP into UHPC mix was leaded to the reduction of workability and compressive strength. In this study found that the increasing the percentage of crumb rubber and microWRP as partial replacement of sand, decrease the flowabilty of concrete. It can observed that percentage of crumb rubber and microWRP as replacement of sand are increase, the compressive strength of rubberized are decreasing.

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LIST OF ABBREVIATIONS

UHPC	Ultra High Performance Concrete
WR	Waste Rubber
WCR	Waste Crumb Rubber
microWRP	Micronized Waste Rubber Powder
OPC	Ordinary Portland Cement
RPC	Reactive Powder Concrete
HRWR	High-Range Water-Reducing Admixture
RWT	Recycle waste tire
SF	Silica Fume
SP	Superplasticizer
W/C	Water-Cement Ratio

CHAPTER 1

INTRODUCTION

1.1 Background

Ultra high performance concrete (UHPC) is widely used throughout the high rise building and bridges worldwide. The UHPC is a concrete possess high durability and high strength when compared with those normal concrete and high-performance concrete (HPC). In the general, UHPC compressive strength can approach a value exceeding 100 MPa (Kusumawardaningsiha and Fehling, 2015; Karmout, 2009). The materials that formulated UHPC was coarse, fine aggregate, very low amounts of water use, high amount of cement, silica fume, and also superplasticizer (Richard and Cheyrezy, 1995). To produce the UHPC is required to reduce the water/binder ratio and increase the binder content. The superplasticiser was introduced as chemical admixtures in the concrete mixture to achieve the required workability. The main problem of UHPC is the usage of the fine aggregate is a lot because to produce it requirement strength. Therefore, the replacement materials for the UHPC concrete mixture is usually use from waste produce that produced by the industry. Waste recycle from by-products are important element because it can help to conserve natural resources and reduce the demand for valuable landfill space. Waste rubber is one significant waste from by-product that has been major concern in the world. This is because the only way to dispose the waste rubber through the burning process. Under this process, it can produce a harmful gas that can threat human health. The rubber waste has been recycled and reuse from the transforms end-of-life tires and other post-industrial rubber into micron-scale powders. In the construction application, the rubber powder has been used as a replacement for fine aggregates. This replacement can be partial or fully replace the sand. The rubber powder is a low-cost, high-performance, and sustainable raw material (Lehigh Technologies, 2014). This

rubber powder is new technology that have been modified for it performance of hardened and the ductal. Therefore, the idea to produce UHPC with rubber are come out, because to produce the UHPC with rubber, the strength of the UHPC will looked into at other materials such as the amount of OPC or amount of water use.

UHPC is a high strength concrete, to achieve the high strength the amount of Ordinary Portland Cement (OPC) used is higher. To cater the amount of OPC used, Silica Fume (SF) was introduced in the mixture of UHPC. This SF is an additional to the OPC for marinating the strength of the concrete strength. Other materials that use as replacement is silica fume. The silica fume is also used in the UHPC as partial substitute to Portland cement because the silica fume has the same characterise as Portland cement. Silica fume is a by-product in the carbothermic reduction of high-purity quartz with carbonaceous materials like coal and wood chips, in the electric arc furnaces in the production of silicon metal or ferrosilicon alloys. In addition. Silica fume is the most popular pozzolana cementitious to produce high strength concrete, due to result in lower porosity, permeability and bleeding when added in the concrete mixtures. The main results of pozzolanic reactions are: lower heat liberation and strength development; lime-consuming activity; smaller pore size distribution. Silica fume add into Portland cement concrete is to improve the properties, in particular its compressive strength, bond strength, and abrasion resistance.

However, in this research only focus out on the physical properties of the UHPC with the concrete properties with the waste produce which is rubber as aggregate substitutes and replacement. Therefore, in the current study, the potential and the physical properties of the concrete aggregates by using waste rubber as an aggregate replacement are to produce the new concrete that will be studied.

1.2 Problem Statement

Ultra-high performance concrete (UHPC), also known as reactive powder concrete (RPC), which is a high-strength, ductile material that combination of Portland cement, silica fume, quartz flour, fine silica sand, high-range water-reducing admixture

(HRWR), water, and steel or organic fibers. The main problem for UHPC is the aggregate used is expensive especially quartz and usage of the fine aggregate is high to produce the required strength. Especially quartz flour as a fine aggregate addition in the UHPC, it is very expensive in the market because the quartz can increase the workability of concrete and reducing the initial porosity of the mixture and thereby increasing the final strength. So replaced with fine sand with quartz but this also cause a problem due to the fine sand now facing a depleted resource. Therefore, the idea to replace the existing materials from waste by-products should be explored.

Nowadays, more industry were build, thus a lot of waste produce were also produced by the industry. In order to alleviate environmental pressures and attain sustainability, one feasible solution is to reuse waste materials as secondary resources. In this regard, the concrete industry has already absorbed millions of tons of industrial by-products that contain toxic elements (Mehta and Monteiro, 2006).

Waste rubber is one significant waste from by-product that has been major concern in the world (Rashad, 2015). Waste rubber is one of the significant waste that contribute to the serious egological treat since it is not easily biodegradable (Pavithran et al., 2015). This is because the only way to dispose the waste rubber through the burning process. Under this process, it can produce a harmful gas that can threat human health. The rubber waste has been recycled and reuse from the transforms end-of-life tires and other post-industrial rubber into micron-scale powders (Lehigh Technologies, 2014). In the construction application, the waste rubber has been used as a replacement aggregates (Eldin and Senouci, 1994; Toutanji, 1996). Thus, in this study the waste rubber also used as a fine aggregates replacement in UHPC.

The potential use of waste rubber, recycled from automobile industry, as fine aggregates in cementitious matrix in order to develop lightweight construction materials have been investigated (Benazzouk, et al, 2007). Form previous study, rubberized concrete mixes may be suitable for nonstructural purposes such as lightweight concrete walls, building facades, and architectural units (Khatib and Bayomy, 1999). Substantial works were reported on the use of polymers such as tire rubber as a replacement for cement, sand or aggregates in concrete mixtures (Eldin and Senouci, 1994; Khaloo, Dehestani; Rahmatabadi, et al 2008); these studies revealed that the addition of rubber to concrete enhanced the elastic behavior, while reducing the compressive strength.

REFERENCES

Ahmad, S., Hakeem, I. & Maslehuddin, M. (2014). Development of UHPC Mixtures Utilizing Natural and Industrial Waste Materials as Partial Replacements of Silica Fume and Sand. Article of Hindawi Publishing Corporation the Scientific World Journal Volume, p.8.

Aiello, M.A. & Leuzzi, F. (2010). Waste tyre rubberized concrete: Properties at fresh and hardened state. Journal of Waste Management, 30, p.1696–1704.

Al-Tayeb, M.M., Bakar, A.B.H., Akil, H.M. & Ismail, H. (2012). Effect of partial replacements of sand and cement by waste rubber on the fracture characteristics of concrete, Polym-Plast. Technol. Eng, Vol.51 (6), p.583-589.

Benazzouk, A., Douzane, O., Langlet, T., Mezreb, K., Roucoult, J.M. & Queneudec, M. (2007). Physico-mechanical properties and water absorption of cement composite containing shredded rubber wastes. Journal of Cement & Concrete Composites, vol.29, p.732–740.

Bignozzi, M.C. & Sandrolini, F. (2006). Tyre rubber waste recycling in self-compacting concrete. Journal of Cement and Concrete Research, 36, p.735–739.

BS 12: (1958). Portland Cement Ordinary and Rapid Hardening. British Standard Method. March 1, 1958.

BS 1881: Part 102 (1983). Method for determination of slump. British Standard Method. May 31, 1983.

BS 1881: Part 108 (1983). Testing concrete. Method for making test cubes from fresh concrete. British Standard Method. July 29, 1983.

BS 1881: Part 111 (1983).Testing concrete. Method of normal curing of test specimens (20°C method). British Standard Method. July 29, 1983.

BS 1881: Part 116 (1983). Method for determination of compressive strength of concrete cubes. British Standard Method. January 31, 1983.

BS 410: (1986). Specification for Test Sieves. British Standard Method. March 31, 1986.

Duval, R. & Kadri, E.H. (1998). Influence of Silica Fume on the Workability and the Compressive Strength of High-Performance Concretes. Journal of Cement and Concrete Research, Vol. 28, No. 4, p.533–547.

Eldin, N. N & Senouci, A. (1994). Measurement and Prediction of the Strength of Rubberized Concrete, Journal of Cement & Concrete Composites, Vol.16, p.287-298.

Ganjian, E., Khorami, M. & Maghsoudi, A.A. (2009). Scrap-tyre-rubber replacement for aggregate and filler in concrete. Journal of Construction and Building Materials, 23, p.1828–1836.

Guneyisi, E., Gesoglu, M. & Ozturan, T. (2004). Properties of rubberized concretes containing silica fume. Journal of Cement and Concrete Research, Vol. 34, p.2309–2317.

Issa, C.A. & Salem, G. (2013). Utilization of Recycled Crumb Rubber as Fine Aggregates in Concrete Mix Design. Journal of Construction and Building Materials, Vol.42, p.48–52.

Karmout, M., 2009. Mechanical Properties of Ultra High Performance Concrete Produced in Gaza Strip. The Islamic University of Gaza, Palestine.

Khaloo, A.R, Dehestani, M & Rahmatabadi, P. (2008). Mechanical Properties of Concrete Containing a High Volume of Tire–Rubber Particles, Journal of Waste Management, 28, p. 2472–2482.

Khatib, Z.K. & Bayomy, F.M. (1999). Rubberized Portland cement Concrete. Journal of Material and Civil Engineering, 11(3), p.206–213.

Kim, H., Koh, T. & Pyo, S. (2016). Enhancing Flowability and Sustainability of Ultra High Performance Concrete Incorporating High Replacement Levels of Industrial Slags. New Transportation Systems Research Center, Korea Railroad Research Institute.

Kusumawardaningsiha, Y., Fehling, E. & Ismail, M. (2015). UHPC compressive strength test specimens: Cylinder or cube?, ScieneDirect, ProcediaeEngineering 125, pp. 1076-1080.

Mehta, P.K. & Monteiro PJ. (1999). Concrete: microstructure, properties, and materials. 3rd ed. New York: McGraw Hill; 2006.Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, editors. *Introduction to the electronic age*, New York: E-Publishing Inc;, p.p 281–304.

Park, J.S., Kim, Y.J., Cho, J.R. & Jeon, S.J. (2015). Early-Age Strength of Ultra-High Performance Concrete in Various Curing Conditions. Article of Materials, Vol.8, p.5537-5553.

Rashad, A.M. (2015). A comprehensive overview about recycling rubber as fine aggregate replacement in traditional cementitious materials, International Journal of Sustainable Built Environment.

Richard, P. & Cheyrezy, M. (1995). Composition of reactive powder concretes. Journal of Cement and Concrete Research, Vol.25 (7), pp. 1501–1511.

Shihada, S. & Arafa, M. (2010). Effect of Silica Fume, Ultrafine and Mixing Sequences on Properties of Ultra High Performance Concrete. Asian Journal of Materials Science, (2), pp.137 – 146.

Shia, C., Meyer, C. & Behnoodc, A. (2008). Utilization of copper slag in cement and concrete. Journal of Resources, Conservation and Recycling, Vol.52, p.1115–1120.

Tayeh, A.I. (2013). Effect of Replacement of Sand by Waste Fine Crumb Rubber on Concrete Beam Subject to Impact Load: Experiment and Simulation. Journal of Civil and Environmental Research, Vol.3, No.13.

Toprcu, B.I. & Avcular, N. (1997). Analysis of Rubberized Concrete as a Composite Material. Journal of Cement and Concrete Research, Vol. 27, No. 8, p. 1135-l 139.

Topcu, B.I. (1997). Assessment of the brittleness index of rubberized concretes. Journal of Cement and Concrete, Res. 27(2), p.177–183.

Toutanji, H. A. (1996). The Use of Rubber Tire Particles in Concrete to Replace Mineral Aggregates. Journal of Cement & Concrete Composes, Vol.18, p.135-139.

"What We Do." What Is Micronized Rubber Powder, Lehigh Technologies, Micronized Rubber Powder (MRP). Retrieved May 10, 2017 from http://www.lehightechnologies.com/index.php/what_we_do/what_is_micronized_rubber_powder/

Yu, R., Spiesz, P. & Brouwers, H.J.H. (2015). Development of an eco-friendly Ultra-High Performance Concrete (UHPC) with efficient cement and mineral admixtures uses. Journal of Cement & Concrete Composites, 55, p.383–394.